

[0078] An external pullup resistor, Rpullup1 116, which may have a value, for example, of 470 Ω , is only necessary if an open collector , comparator such as an LM393 154 is used. That comparator 154 acts as an open-collector output with a ground-coupled emitter. For low power consumption, better performance is achieved with a CMOS comparator, e.g., TLC3702, which utilizes a cmos push-pull output 156. The signal at terminal 3 110 of U1A charges a capacitor Cref 92 and also charges an ANT sensor 100 with a capacitance which Cref 92 is designed to approximate. A value for Cref for the schematic of Figure 8A, for the most current board design, upon which it depends, is about 10 pF. As the clocking square wave is effectively integrated by Cref 92 and the capacitance of ANT 100, two exponential signals appear at terminals 5 104 and 6 106 of the second comparator U1B, through the Rprotect 160 static protection resistors. Rprotect 160 resistors provide limiting resistance which enhances the inherent static protection of a comparator input lines, particularly for the case of pin 5 104 of U1B 102. In the schematic shown in Figure 8A, a typical value for Rprotect 160 might be 2 k Ω . One of the two exponential waveforms will be greater, depending upon the settings of the adjustable resistance Rtrim 96, Cref 92, and ANT 100. The comparator U1B 102 resolves small differences, reporting logic levels at its output, pin7 118. As the waveforms may initially be set up, based on a capacitance at ANT 100 of a given amount. However, upon the intrusion of a hand, for example, into the detection field of the antenna ANT 100, the capacitance of ANT 100 is increased significantly and the prior relationship of the waveforms, which were set with ANT 100 with a lower capacitance, are switched over. Therefore, the logic level output at pin 7 118 is changed and the d flip-flop 108 state is changed via the input on pin 5 of the D flip-flop 108.

[0079] The second comparator 102 provides a digital quality signal to the D flip-flop 108. The D flip-flop, U2A 108, latches and holds the output of the comparator U1B 90. In this manner, the second comparator is really doing analog-to-digital conversion. A suitable D flip-flop is a Motorola 14013.

[0080] The presence, and then the absence, of a hand can be used to start a motorized mechanism on a paper towel dispenser, for example. An embodiment of the proximity detector uses a single wire or a combination of wire and copper foil tape that is shaped to form a detection field. This system is very tolerant of non-conductive items, such as paper towels, placed in the field. A hand is conductive and

attached to a much larger conductor to free space. Bringing a hand near the antenna serves to increase the antenna's apparent capacitance to free space, forcing detection.

[0081] The shape and placement of the proximity detector's antenna (Fig. 8A, 100) turns out to be of some importance in making the proximity sensor work correctly. Experimentation showed that a suitable location was toward the lower front of the dispenser unit. The antenna (Fig. 8A, 100) was run about two-thirds the length of the dispensing unit, in a modular, replaceable unit above the removable dispensing shelf 62 (Fig. 3). This modular unit would be denoted on Figure 3 as 120.

[0082] A detection by the proximity detection circuit (Fig. 8A) in the module 120 sets up a motor control flip flop so that the removal of the hand will trigger the start of the motor cycle. The end of the cycle is detected by means of a limit switch which, when closed, causes a reset of the flip-flop and stops the motor. A cycle may also be initiated by closing a manual switch.

[0083] A wide range of sensitivity can be obtained by varying the geometry of the antenna and coordinating the reference capacitor. Small antennae have short ranges suitable for non-contact pushbuttons. A large antenna could be disposed as a doorway-sized people detector. Another factor in sensitivity is the element applied as Rtrim. If Rtrim 96 is replaced by an adjustable inductor, the exponential signals become resonant signals with phase characteristics very strongly influenced by capacitive changes. Accordingly, trimming with inductors may be used to increase range and sensitivity. Finally, circuitry may be added to the antenna 100 to improve range and directionality. As a class, these circuits are termed "guards" or "guarding electrodes," old in the art, a type of shield driven at equal potential to the antenna. Equal potential insures no charge exchange, effectively blinding the guarded area of the antenna rendering it directional.

[0084] The antenna design and trimming arrangement for the paper towel dispenser application is chosen for adequate range and minimum cost. The advantages of using a guarded antenna and an adjustable inductor are that the sensing unit to be made smaller.

[0085] From a safety standpoint, the circuit is designed so that a detection will hold the motor control flip-flop in reset, thereby stopping the mechanism. The cycle can then begin again after detection ends.

[0086] The dispenser has additional switches on the control module 54. Figure 3 shows a "length-of-towel-to-dispense-at-one-time" ("length")switch 134.

